



NASA Science in the Middle of Nowhere:

Measuring Greenhouse Gases in Railroad Valley, NV

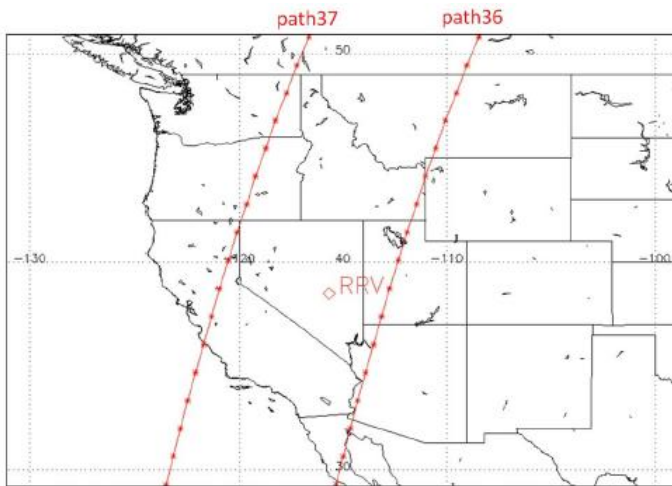
Laura T. Iraci
NASA Ames Research Center
Moffett Field, CA



Why Railroad Valley?



- Multi-year history of JPL campaigns to calibrate radiance measurements
- RRV Playa (dry salt lake)
 - High reflectance, spectrally flat
 - Playa larger than footprint (10.5km)
 - Very low aerosol optical thickness
 - Very low population and vegetation
 - High clear sky ratio.
- Other RRV participants: JPL, JAXA, ColoState; Univ Wisconsin





ARC Railroad Valley: June 17-26 2011

- Measure Greenhouse Gas (GHG) vertical profiles from Alpha Jet and SIERRA Unmanned Aircraft System (UAS)
- Provide data to support calibration of GOSAT
- Explore local sources of carbon dioxide (CO_2) and methane (CH_4)



Alpha Jet



SIERRA UAS





Study Area

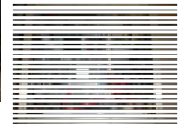
- Play a Google Earth "tour" from ARC to RRV, then down into the Alpha data spiral, then out to SIERRA mapping field. (approx 45 sec)





Measuring GHG Vertical Profiles

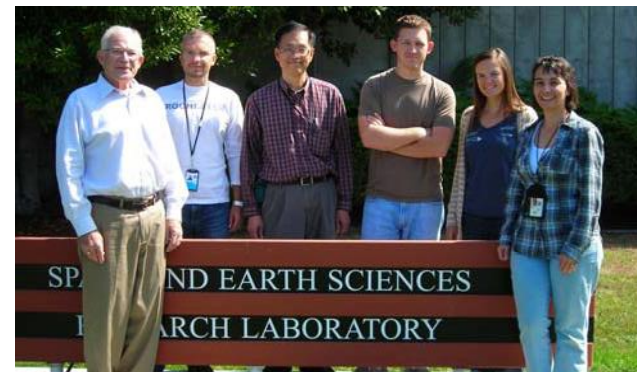
- Commercial optical instrument
 - Picarro G2301-*m* CRDS
 - Reconfigured for flight
- Alpha Jet fighter trainer
 - 25,000 ft spiral down to 100 ft agl
 - instruments suspended in wing pod
 - also carries ozone instrument
 - vertical profiles under GOSAT
 - June 22, 23, 25, 26



Picarro G2301-*m*
repackaged for flight



F. Schwandner

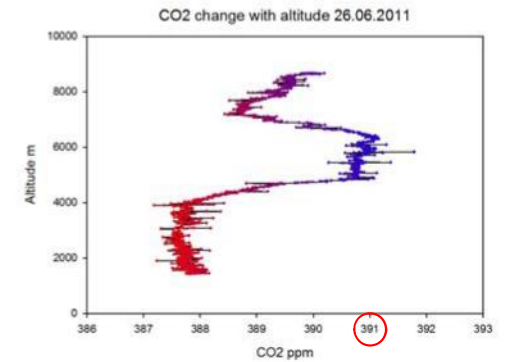
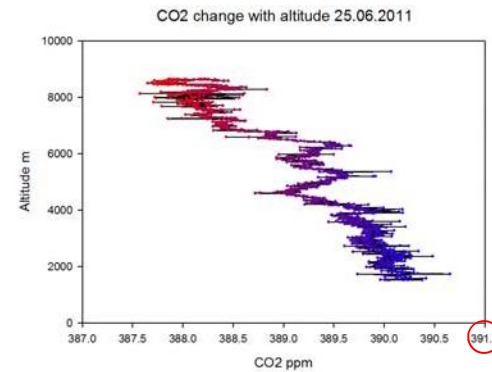
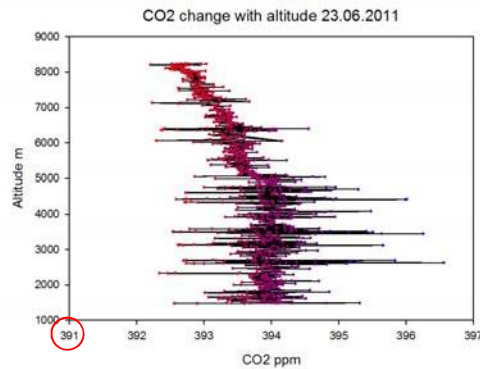


ARC Team includes (from left) Max Loewenstein, Jovan Tadic, Warren Gore, Ryan Walker, Emma Yates, Laura Iraci

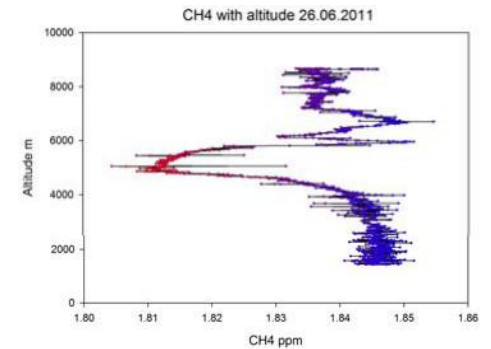
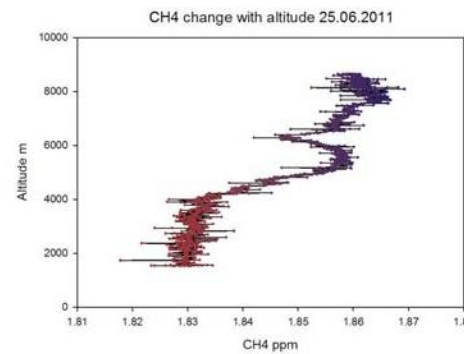
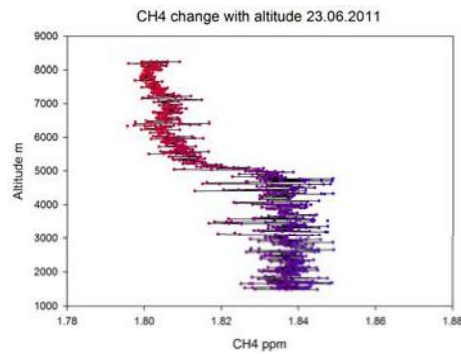


Measuring GHG Vertical Profiles

CO₂



CH₄



Blue = more CO₂, CH₄

Red = less CO₂, CH₄



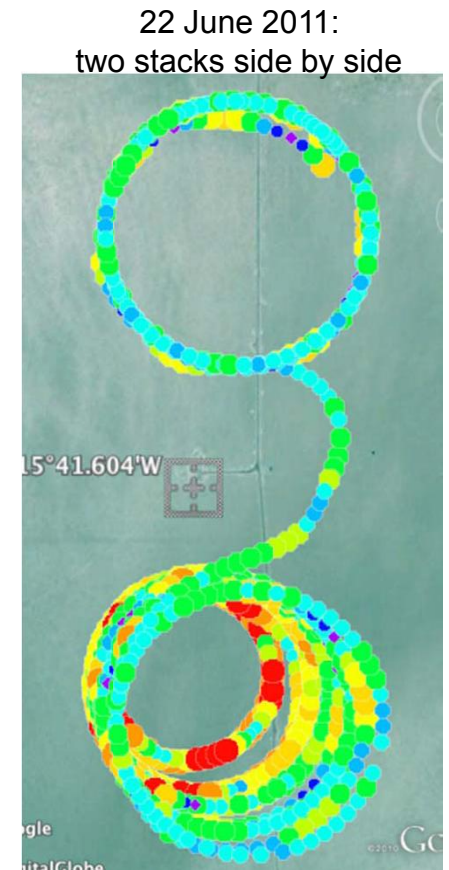
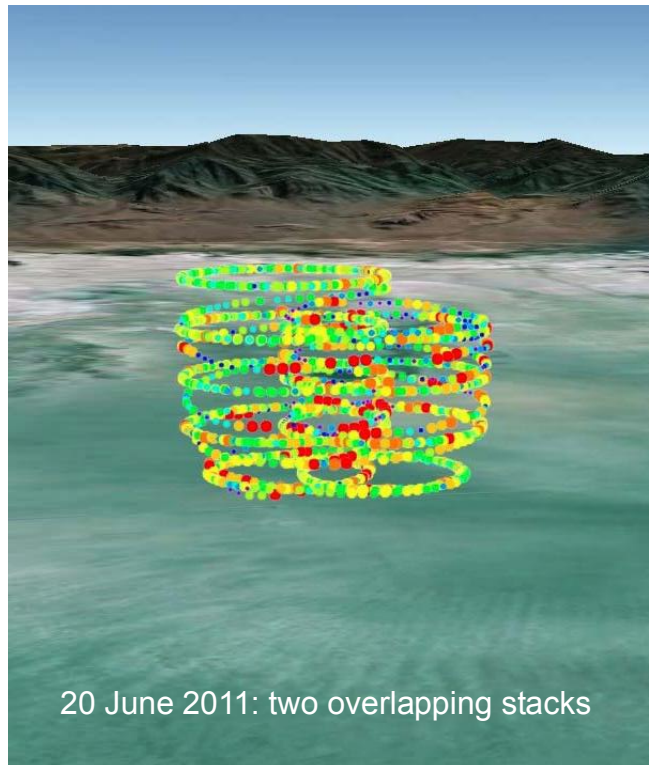
Measuring GHG Vertical Profiles

- show video from Alpha (45 - 60 sec)



CO₂ Near-Surface columns from SIERRA

- Remotely piloted to extend data collection and reduce risk
- Flew stacked circles up to ~2500 ft agl
- Carries Picarro G2301-*f* CRDS CO₂/CH₄ sensor
 - modified for flight
 - also 3-D wind measurements for flux determination





Supporting GOSAT with CO₂ Data

- JAXA's GOSAT
 - carries TANSO-FTS
 - reports XCO₂ (column average dry mole fraction)
- ARC in-situ GHG data
 - ground truth for comparison to remote measurement



JPL/JAXA Field campaign organized by (left to right): A. Kuze, M. Helmlinger, C Bruegge





Supporting GOSAT with CO₂ Data



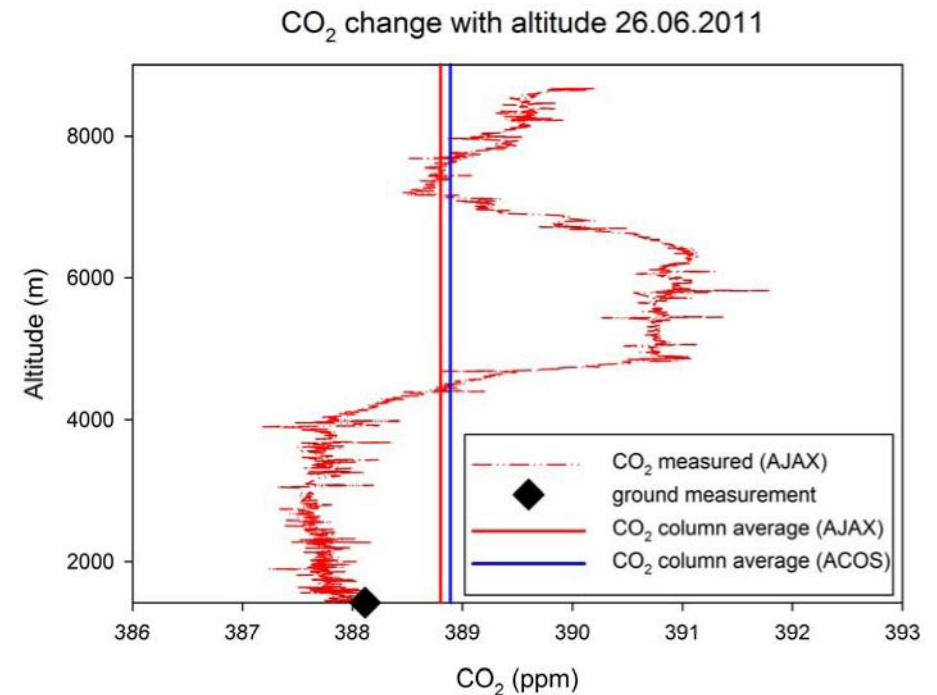
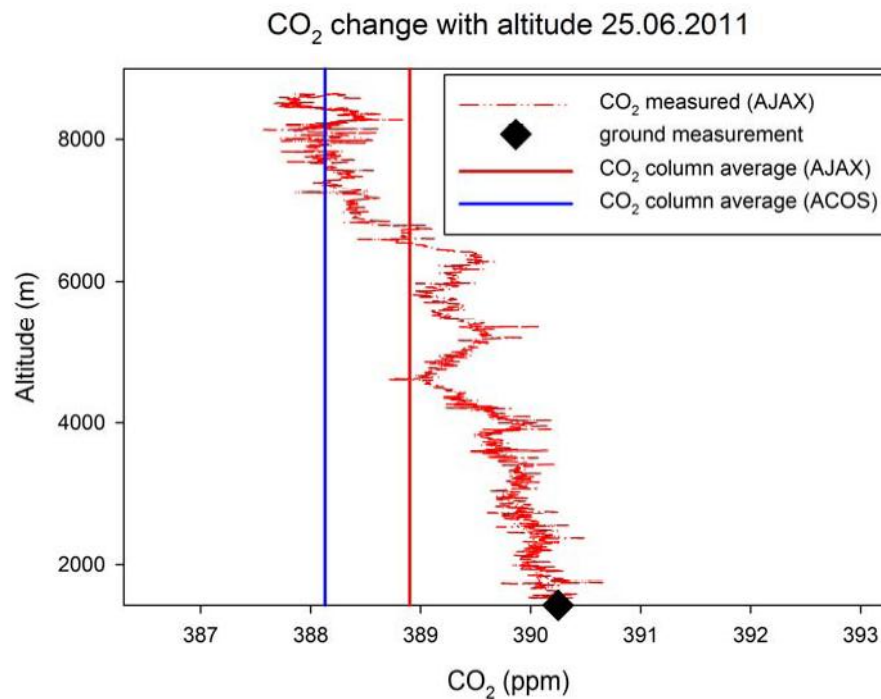
- CO₂ and CH₄ measurements during each GOSAT overpass
 - ground-based Picarro model G2311-f
 - sonic anemometer





Supporting GOSAT with CO₂ Data

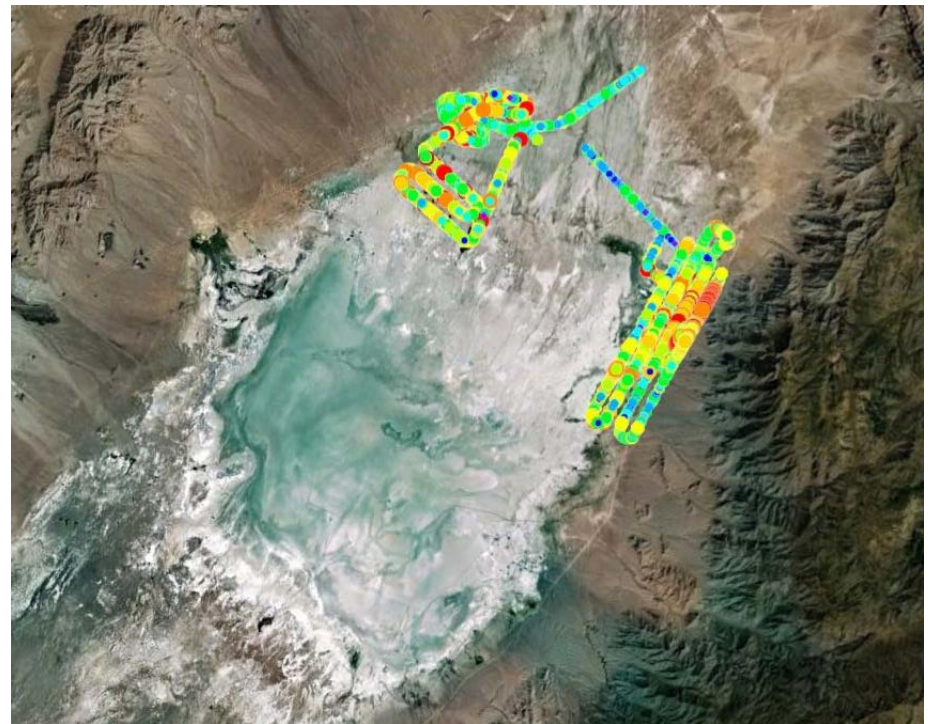
- **Pressure-weighted average** of in-situ data, compared to satellite retrievals





Exploring Local Sources of Methane

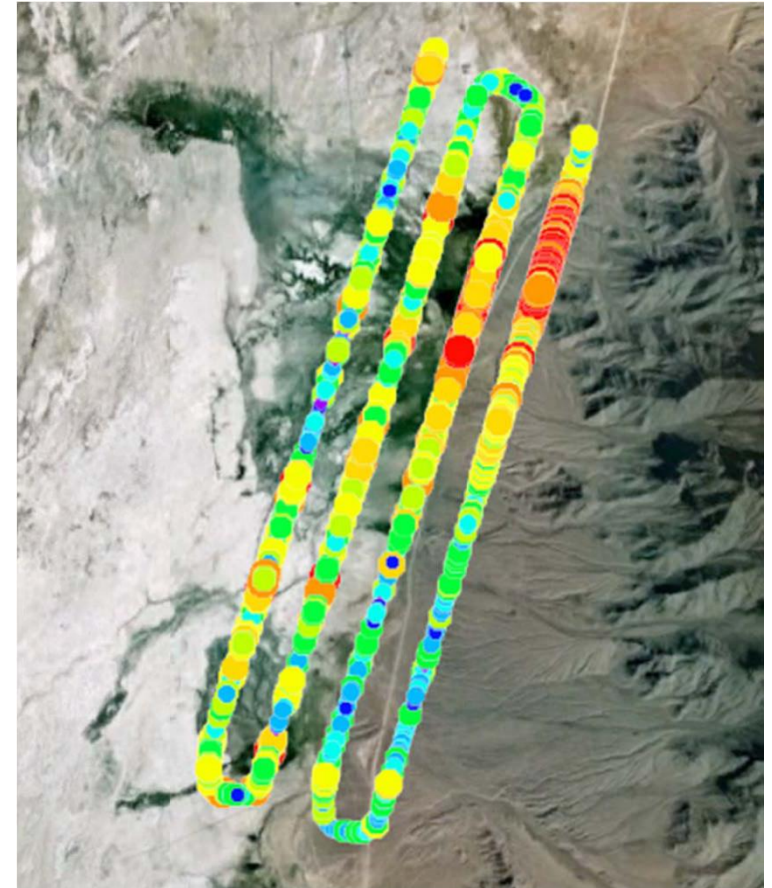
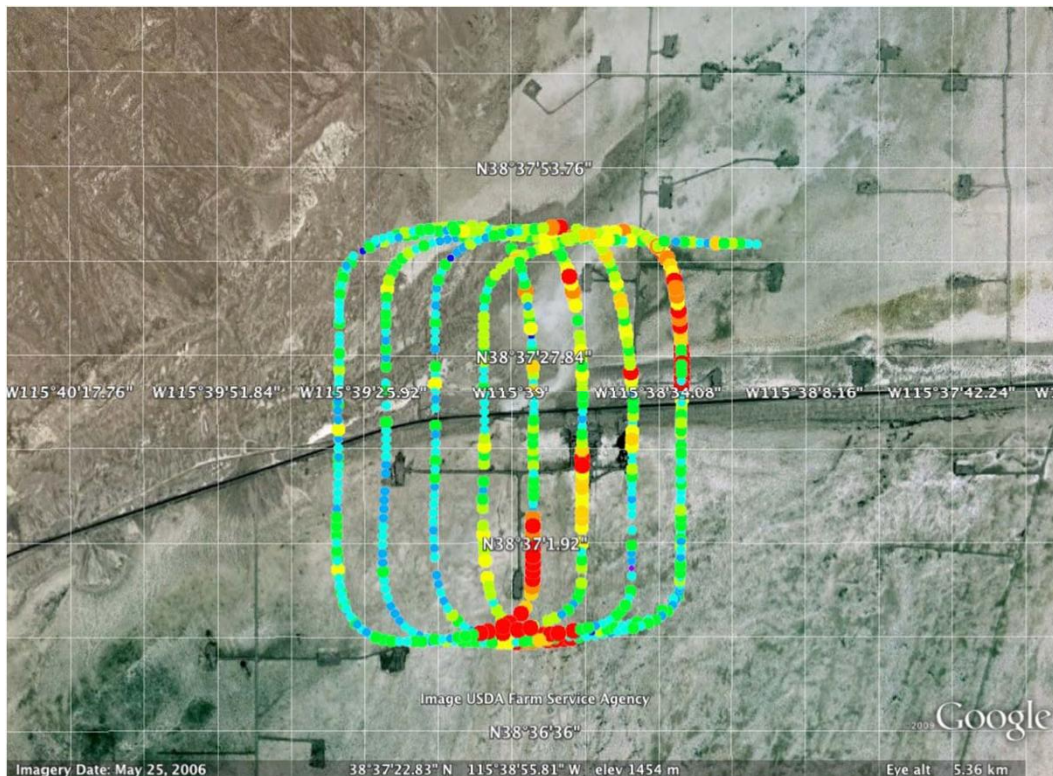
- SIERRA takes off for a mapping mission
 - <http://vimeo.com/26199759> (58 sec)





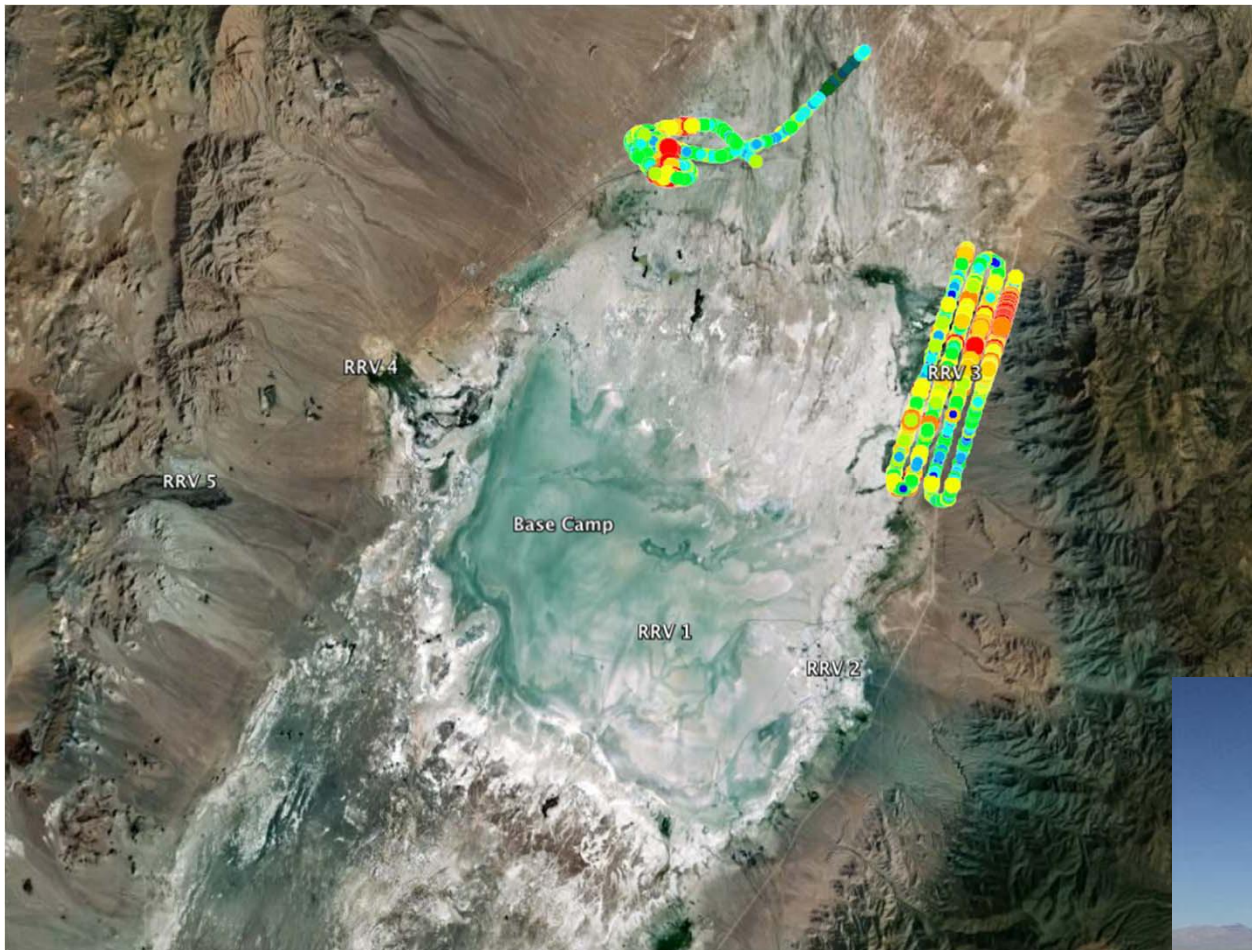
Exploring Local Sources of Methane

- Hot Spot Identification:
 - cold springs (right)
 - oil infrastructure (below)
 - level flights at XXX m above ground level
 - red = more CH_4 , blue = less





Ground-Truthing Methane Hot Spots

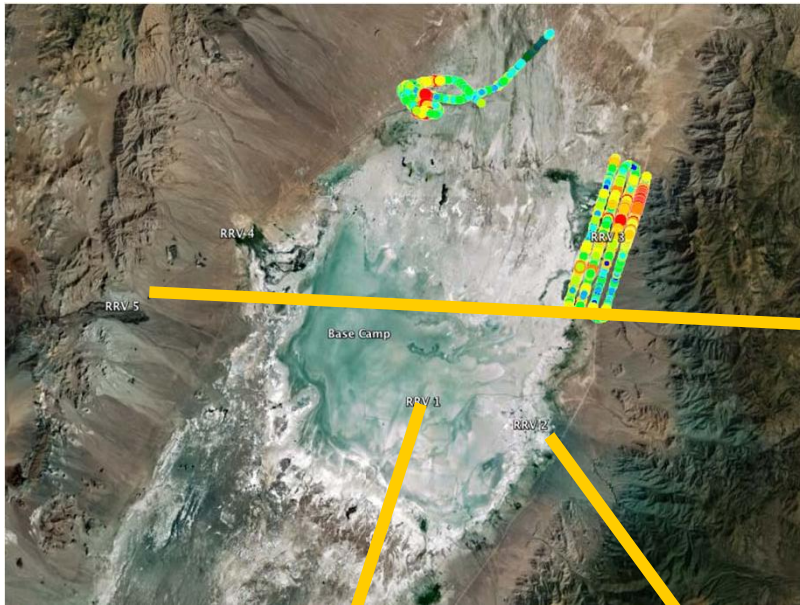


- Mobile GHG lab deployed from Base camp to RRV 3 and RRV 6
- Soil gas and microbiology measurements taken to determine the source of methane





Determining Methane Origins



Hydrothermally altered rocks at Pancake Ridge



Playa (inactive oil derrick)

Edge of playa; more vegetated





Kate Springs (RRV3)



- Cold spring
- Collected bubbles
- $\text{CH}_4 = 84.32 \pm 0.13 \%$
- $\text{C}_2\text{H}_6 = 7.88 \pm 0.16 \text{ ppm}$
- $\text{C1/C2} = 105000$





Black Rock Station (RRV 4)



- Geothermal spring (37°C)?
- Collected bubbles
- $\text{CH}_4 = 69.38 \pm 9.21 \%$
- $\text{C}_2\text{H}_6 = 3.46 \pm 0.3 \text{ ppm}$
- $\text{C1/C2} = 183000$
- Conclusions:
 - Methanogens are present and active in springs, but not prominent on crust or subsurface layers of the playa
 - $\delta^{13}\text{C}$ of CH_4 from bubbles collected in the natural springs (RRV3 and RRV4) fall in the biogenic range



Co-Authors & Many Thanks

- ARC ground based team: E Yates, K Schiro, E Sheffner, A Detweiler, C McKay, J DeMarines, C Kelley (U. Missouri)
- ARC Alpha jet team: M Loewenstein, J Tadic, W Gore, A Trias, E Quigley, R Walker
- SIERRA team: M Fladeland, R Berthold, M Sumich, R Kolyer
- H211 / Alpha crew
- JPL / JAXA: C Bruegge, A Kuze, M Helmlinger
- Others at Base Camp: F Schwandner
- Data analysis and other assistance: D Wunch, C Frankenburg, B Bebout, C Thomas



Come Join Us!

- NASA Postdoctoral Program (nasa.orau.org)
- Ames has four open civil service slots with airborne, satellite, instrumentation, and modeling foci
- Undergrad Internships: <http://intern.nasa.gov/>
- Laura.Iraci@nasa.gov





Learn More:

- Today

- A33C-0234. In situ measurements of carbon dioxide (CO₂), methane (CH₄), and ozone (O₃) over the Sierra Mountains of central California and western Nevada; Rebekah A. Olson
- A33C-0236. An Observing Architecture for Synthesis of Multi-platform Observations of Carbon Dioxide over Railroad Valley, NV; Laura T. Iraci
- A33C-0240. Development of a new platform for airborne measurements of atmospheric CO₂ and CH₄ and comparison with GOSAT measurements at Railroad Valley playa, Nevada; Jovan Tadic
- A33C-0241. Automated network at Railroad Valley, Nevada, for providing radiometric calibrations of OCO₂; Carol J. Bruegge
- A33C-0237. Retrieval of surface albedo over the Railroad Valley playa from AVIRIS measurements; Thomas Taylor
- A33C-0207. Validation of the GOSAT Thermal Infrared (TIR) Band using the University of Wisconsin airborne Scanning High-resolution Interferometer Sounder (S-HIS) and ground-based Atmospheric Emitted Radiance Interferometer (AERI) at Railroad Valley, Nevada; Robert Knuteson

- Tomorrow

- A41B-0089. In-Situ Greenhouse Gas Measurement Comparisons in Railroad Valley, NV to Identify Local Point Sources and Quantify their Influences on Observed Background Concentrations; Kathleen A. Schiro
- A41B-0090. Spatial and temporal variability in atmospheric CO₂ and CH₄ at Railroad Valley playa, a mid-latitude desert site; Emma L. Yates
- A42D-07 (ORAL). Vicarious calibration and validation campaign of the GOSAT sensors at Railroad Valley; Akihiko Kuze (room 3008)

- Friday

- B51G-0486. Ground truthing for methane hotspots at Railroad Valley, NV - application to Mars; Angela M. Detweiler
- Yesterday: B14A-06 (ORAL). SIERRA-Flux: measuring regional surface fluxes of carbon dioxide, methane, and water vapor from an unmanned aircraft system; Matt Fladeland
- Picarro booth #1401